Simulating high impact wildfire and wind-blown dust events using improved atmospheric modeling methods

Wildfires and wind-blown dust events are projected to increase through the end of the 21st century as a result of warmer temperatures and increasing aridity. As a result, there is a significant need to develop air quality modeling frameworks that can simulate the impacts of fires and dust in the future. Atmospheric transport and chemistry models often have a difficult time resolving the transport of smoke from wildfires, primarily due to deficiencies in estimating the plume injection height, which has been highlighted as an important aspect for simulating smoke transport. An atmospheric transport model that included a plume-rise parameterization was applied to a prescribed burn at Eglin Air Force Base, FL in an effort to evaluate existing smoke modeling frameworks with well-constrained input parameters. After determining the optimal model configuration, the modeling framework was applied to a regional case study centered on Utah during the summer of 2012.

A new dust modeling framework that uses a backward Lagrangian particle dispersion model is presented here. The performance of the model was tested during the spring of 2010 at multiple sites across northern Utah. Initial model results showed that the model was unable to reproduce a significant wind-blown dust event on 30 March 2010. The backward Lagrangian approach presented here allowed for the easy identification of dust source regions with misrepresented land cover and soil types, which required an update to WRF. In addition, changes were also applied to the dust emission model to better account for dust emitted from dry lake basins. These updates significantly improved dust model simulations with modeled PM$_{2.5}$ comparing much more favorably to observations. Next, the dust model was applied to future Great Salt Lake (GSL) water level scenarios in an effort to quantify the impacts that a desiccating GSL would have on air quality across Utah. Results here suggest that even small changes in lake levels could have significant impacts on dust production and air quality along the Wasatch Front, with PM$_{2.5}$ increasing by a factor of two during extreme dust events.

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